SEQUEL TO "HIPPELATES (EYE GNAT) INVESTIGATIONS IN THE SOUTHEASTERN STATES" BY JOHN T. BIGHAM[1]

(DIPTERA, CHLOROPIDAE)

By RICHARD P. DOW,[2] JOHN T. BIGHAM,[3] AND CURTIS W. SABROSKY[4]

When it becomes advisable to review biological observations in the light of later taxonomic revisions, all too frequently the specimens on which the results were originally based are found to have been misplaced or destroyed. Though such is now the case in respect to most of the *Hippelates* studied by J. T. Bigham in 1937-1939, much of his material was subsequently reviewed by C. W. Sabrosky who returned most of the specimens (now lost), but carefully preserved the determination records. By themselves, these identifications had no biological meaning, but quarterly reports on the experimental studies were also available, and since the field work had been reported in great detail, it seemed possible to coordinate the two sets of data.

Bigham's investigations had been completed before Sabrosky described *Hippelates bishoppi* as a new species,[5] based in part on Bigham's material. Because the collections studied by Sabrosky, which included a total of 40,463 Chloropidae, contained 8,018 specimens of *H. bishoppi* together with 31,726 of *H. pusio*, it seemed advisable to find out whether Bigham's conclusions regarding *pusio* were to any degree compromised by such a large number of a previously unrecognized species, and whether a complete analysis of all the data would provide any new biological information on either *pusio* or *bishoppi*.

Of the 1,035 lots of Chloropidae identified by Sabrosky, it has been necessary to omit from this study a total of 16. Twelve of these lots, which consisted of specimens removed from whole trap catches, represented biased samples; two were the results of a special experiment; and two had questionable or insufficient data. The remaining 40,207 specimens were obtained by one of three methods: hand collecting, trapping with a bait of decayed liver, or setting recovery cages to secure adults which had bred in the ground or other material beneath them.

It appears that a fair proportion of the hand-collected specimens were sent to Sabrosky, but only a small number of

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the very numerous and often gigantic trap collections were included in this material. On the other hand, Sabrosky received practically all of the very important collections obtained from the recovery cages. A summary of Sabrosky's identifications arranged by type of collection (Table 1) provides unexpected data regarding the biology of various Chloropidae. Whereas *Hippelates pusio, H. bishoppi, H. plebejus,* and *Oscinella triorbiculata* were all reared from the soil as well as attracted to decayed liver, the following species occurred only in trap or hand collections: *Hippelates nobilis, H. pallipes, H. particeps, H. proboscideus, Oscinella carbonaria,*and *O. grisescens.* Moreover, *Hippelates dissidens* (with one exception), *Madiza cinerea,* and *Elachiptera umbrosa* were collected only from recovery cages. These statements are all based on specimens taken on at least three occasions.

TABLE 1

Summary of specimens of Chloropidae, compared by type of collection, with genera, also species within genera, listed in order of decreasing frequency

	Hand	Baited trap	Recovery cage
Hippelates pusio Loew	472	22,504	8,524
H. bishoppi Sabr.	7	6,419	1,591
H. particeps (Becker)		106	
H. proboscideus Will.	3	85	
H. dissidens (Tucker)		1	56
H. plebejus Loew	2	14	35
H. pallipes (Loew)	14	16	
H. nobilis Loew	7	15	
H. dorsalis Loew	3	1	
H. flaviceps (Loew)		1	
H. sp.	3	19	5
Oscinella carbonaria (Loew)		60	
O. triorbiculata Sabr.		8	9
O. grisescens Sabr.	4	11	
O. coxendix (Fitch)			1
O. sp.	1	104	1
O. or H. sp.			1
Madiza cinerea (Loew)			50
M. trigramma (Loew)		4	1
M. parva (Adams)			1
M. sp.			2
Elachiptera umbrosa (Loew)			29
Rhodesiella brimleyi Sabr.			16
Ceratobarys eulophus (Loew)			1
	516	29,368	10,323

It should be noted, however, that some of the recovery cage material was collected from settings which at the present time are not known to have been made on cultivated or otherwise disturbed ground. These lots may be summarized as follows:

over pile of grass in corner of grove, Orlando, Fla.: 5 *Hippelates dissidens*, 16 *Rhodesiella brimleyi*, 1 *Ceratobarys eulophus;*

over celery scraps left in field, Sanford, Fla.: 3 *H. dissidens*, 27 *Elachiptera umbrosa;*

over muck soil (perhaps disturbed), Oviedo, Fla.: 1 *H. dissidens;*

over surface for which no data are available, Orlando, Fla.: 1 *H. dissidens*, 4 *Oscinella triorbiculata*, 1 *Madiza trigramma.*

These records indicate that the mere collection of a species of chloropid from a recovery cage does not in itself establish the soil proper as the site of larval development. On the other hand, the recovery of *pusio* and *bishoppi* from strip after strip of plowed land indicates that, whatever the actual food, the soil is the natural habitat of these species, and the same may be true of *H. plebejus.*

Collections Made by Hand

Among the 50 lots of hand-collected specimens, 17 which are associated with biological data seem important enough to report in detail. Fifteen of these involve only *H. pusio.* It is noteworthy, but perhaps not of significance, that *H. bishoppi*, which could be expected to occur in the same localities, is completely absent in the following records. The numbers of *pusio* are included in parentheses.

Mendenhall, Miss., September 17, 1937: from horse with eruption on shoulder (5).

McGee, Miss., September 17, 1937; from eyes of calf with pinkeye (9).

Laurel, Miss., September 18, 1937: from eyes of calf with pinkeye (3, 4, 20, 6).

Cairo, Ga., September 28, 1937: from yearling calf with screwworm infestation on leg (3).

Thomasville, Ga., September 28, 1937: from cow with wound on side (7); from cow (18); from cow with skin disease (8).

Valdosta, Ga., October 4, 1937: from wound on sheep (77); from cut on dog's leg (9); from wound on goat (65).

Albany, Ga., October 6, 1937: from steer with pinkeye, shipped from Texas (14, and one *Oscinella* sp.); from heifer with pinkeye, shipped from Texas (12).

Winter Park, Fla., May 18, 1938: caught in schoolhouse (4).

Ormond, Fla., May 22, 1939: around eyes of man in marsh (7 *Hippelates nobilis*, 3 *H. proboscideus*, 2 *H. plebejus*, 4 *Oscinella grisescens*).

The remainder of the hand-collected material includes nothing of special interest except that *pusio* was present in 30 out of 33 lots from Texas, Louisiana, Mississippi, Alabama, Georgia, and Florida, and *bishoppi* occurred in only three lots (twice with *pusio*) from Mississippi and Alabama.

Collections from Traps

The 117 trap collections which were sent to Sabrosky represent not only a small fraction of all the catches from the status or prevalence traps, as already stated, but the lots are extremely scattered as to both locality and season. It is therefore impossible to obtain from this material any satisfactory picture of the seasonal distribution or relative abundance of *bishoppi* and *pusio*. In individual trap collections, however, *bishoppi* frequently outnumbered *pusio*. This occurred in several lots from Zellwood, near Orlando in central Florida, and at various other localities both north and south of that region. The lots from central Florida, including Orlando, Sanford, and Zellwood, were selected mostly from collections made in November, and those from the areas to the north and south mostly from collections made in August and June, respectively (Table 2). In spite of the fact that the records are unequally distributed by locality and season, it appears that *bishoppi* was more common at Zellwood than at Orlando and Sanford, also relatively more common there in relation to *pusio*.

Table 2

Summary of trap collections containing *Hippelates pusio* and *bishoppi*, by locality

Locality	Months represented in collections[1]	Total lots	No. of *pusio*	No. of *bishoppi*	Percent of *bishoppi*
Orlando, Florida	*Jan., Aug.-Nov.*, Dec.	61	12,152	73	0.6
Sanford, Florida	Jan., *Aug.*, Nov., Dec.	9	3,509	6	0.2
Zellwood, Florida	*Jan., Sept., Nov., Dec.*	15	1,892	243	11.4
Northern Florida, southern Georgia, southern Alabama	Jan., *Febr., Aug.*	17	2,797	2,761	49.7
Southern Florida	*Jan., Febr., June, Aug.*	13	2,154	3,336	60.8

[1]Italics indicate months when *bishoppi* was trapped in addition to *pusio*.

Collections from Recovery Cages

The discussion of the breeding habits of *pusio* presented in the original article was based on the work with recovery cages. Besides the miscellaneous settings, which produced *pusio* or *bishoppi* only where the soil had been disturbed, there were three other series of observations: the *experimental* settings, to determine the length of time that *pusio* would continue to breed in turned soil, the breeding activity at different seasons, and the possible effect of the cages on the normal development of the larvae; the *seasonal* settings, to determine the most practical time for cultivating land to control breeding; and the *cultural* settings, to determine the effect on breeding of different methods of preparing soil (Table 3).

Excepting the miscellaneous settings and part of the experimental settings, the tables in Bigham's quarterly reports give weekly totals of all gnats obtained from the recovery cages, whereas the lots studied by Sabrosky consisted of the separate collections. Less than ten of the weekly totals were not represented in Sabrosky's material, but there are numerous cases in which the numbers of specimens recorded by Sabrosky fail to tally with Bigham's figures. Sabrosky's identifications include 9,568 specimens out of a total of 9,891 reported from the experimental, seasonal, and cultural settings. The difference of 323 specimens (less than 3.3%) is quite evenly distributed throughout the settings, and in only two of the separate plowed strips does the difference exceed 10% (10.4 and 16.7). The minor nature of the discrepancies is well shown by the following changes which Sabrosky's records would make in Table 1 of the original paper (page 442). All of Sabrosky's specimens were *pusio* except the single individual, a *plebejus*, which was collected at Zellwood in the third week from the first cage set on October 4; apparently 6 *pusio* instead of 4 were obtained in the third week from the second cage set at Orlando on September 7; and in the recoveries of the fourth week at Zellwood, only 7 *pusio* instead of 11 and 5 instead of 6 could be accounted for. All in

Table 3

Summary of recovery cage collections containing *Hippelates pusio* and *bishoppi*, by series of cage settings

Series of settings	Dates of settings	Localities	No. of *pusio*	No. of *bishoppi*
Miscellaneous	1937-1939	(various)	620	61
Experimental	Aug.-Dec., 1938	Orlando, Zellwood	498	1
Seasonal	Mar.-Aug., 1939	Zellwood, Sanford	6,175	1,529
Cultural	July 1939	Sanford	1,231	0

all, the irregularities are probably of no importance because they are widely scattered.

Though it is clear from Table 3 that the ratio of *bishoppi* to *pusio* varies under different circumstances, it is also apparent that the conclusions regarding *pusio* (at least those based on the experimental and cultural settings) remain unchanged It was desirable to show, however, that the numbers of *bishoppi* did not affect the results of the seasonal settings. These tests, mentioned briefly on page 443 of the original article, were conducted as follows. On one plot of land at Zellwood in a region characteristic of the "ridge" citrus-growing section with a soil of deep, loose sand, and on another plot of land at Sanford in a typical trucking area, where the soil was also sandy, ten strips were plowed at regular intervals, two each month, from March to July inclusive. Eight recovery cages were set on each of these 20 strips from 9-16 days after the plowing, and collections of gnats were usually made from them at approximately weekly intervals.

The distribution of *pusio* was remarkably uniform within the seasonal plots, occurring in all the cages set at Zellwood and in all but two at Sanford. Moreover, *bishoppi* was collected from 66 of the 80 cages at Zellwood, being absent from only 4 cages up to those set on the two strips last plowed. At Sanford, however, where *bishoppi* was found in only 37 of the 80 cages, it more obviously became less frequent as the season progressed, occurring in 5, 8, 6, 5, 2, 4, 3, 3, 1, and 0 cages in the successive strips.

Because of the comparatively infrequent collection of gnats from the recovery cages as well as the climatic factors concerned, it is impossible to determine accurately from the seasonal settings an average time of development for either *pusio* or *bishoppi*. From date of plowing to date of collection, the average for *pusio* in the separate strips ranged from 55 to 23 days at Zellwood and 42 to 22 days at Sanford. Comparable figures for *bishoppi* are 49 to 21 days at Zellwood and 36 to 20 days at Sanford. The maximum period of development for both species occurred in the first strips plowed at Zellwood and Sanford on March 11 and March 14, respectively. There is a possibility that some of the gnats recovered belonged to a second generation which had bred under the recovery cages, but this seems rather unlikely because there is a continuous decrease in the average time of development for both species in the first five strips plowed at successively later dates in the spring. The slight difference in the figures for the two species is of questionable significance.

When the seasonal recoveries from the strips which were plowed in the same month were grouped together by locality,

there was found to be considerable fluctuation in the actual numbers of *pusio* and *bishoppi*, but the percentage of *bishoppi* at Zellwood decreased from March to July as follows: 42.0, 34.6, 31.3, 11.4, 2.3. At Sanford also, the percentage decreased regularly during the same months except in May: 6.7, 3.1, 14.4, 2.7, 0.7. When the recoveries were grouped by *month of collection*, there was a similar over-all decrease in the percentage of *bishoppi* in both localities (Table 4).

It is unfortunate that the seasonal settings at Zellwood and Sanford did not cover an entire year, but they confirm the previous statements about *pusio*, and also contain sufficient evidence to show that *bishoppi* resembles *pusio* in its breeding habits. From the similar period of development and its wide distribution in the plowed strips, *bishoppi* also appears to lay its eggs in freshly turned soil and to breed mainly in cultivated ground. This statement is further supported by evidence from the rest of the cage settings.

Discussion

It has been possible to show that the conclusions of the previous article regarding *Hippelates pusio* have not been affected by the discovery of a large percentage of *H. bishoppi* in the most critical material. Moreover, *bishoppi* has been found to have similar breeding habits. It remains to be found whether the available data establish any difference in the seasonal or other distribution of the two species. A summary of all the cage collections arranged by locality (Table 5) shows that *pusio* has been recovered in the Orlando region, which includes Sanford, Zellwood, and Oviedo, in all months of the year, but that *bishoppi* has been taken only in the period from February to September. This is contradicted in part by the

Table 4

Recoveries of *Hippelates pusio* and *bishoppi* by month from the seasonal settings at Zellwood and Sanford, Florida

	Zellwood			Sanford		
Month	No. of *pusio*	No. of *bishoppi*	Percent of *bishoppi*	No. of *pusio*	No. of *bishoppi*	Percent of *bishoppi*
April	145	132	47.6	405	32	7.3
May	1,403	767	35.3	757	31	3.9
June	1,214	493	28.9	295	23	7.2
July	260	19	6.8	1,110	27	2.4
August	351	5	1.4	235	0	0.0
	3,373	1,416		2,802	113	

trap collections from the same region (Table 2) which include no catches made from February through July but have records for both species in all the months represented. More detailed examination of the trap catches shows that the percentage of *bishoppi* at Orlando decreased regularly from August (3.7%) to December (0.0%) and then rose (to 2.6%), the species appearing in one of three catches taken in January. When these indications are considered in relation to the over-all decrease of *bishoppi* found in the seasonal settings, it appears that in the Orlando region during the periods represented by the collections, *pusio* was more or less abundant and bred throughout the year, whereas *bishoppi*, though taken as an adult in each month of the year, bred mostly in the spring from March through May. Regarding the occurrence of the two species by locality, both trap and cage collections indicate that *bishoppi* was relatively more common in the places sampled at Zellwood than at either Sanford or Orlando. It is felt that this apparent distribution is real and that it bears a possible relation to different types of soil.

SUMMARY

Over 40,000 of the Chloropidae collected by J. T. Bigham in the course of his investigations on *Hippelates pusio* in 1937-1939 were subsequently studied by C. W. Sabrosky and found to contain a large percentage of *H. bishoppi* Sabrosky, a new species of *Hippelates*. An analysis of these identifica-

TABLE 5

Summary of all recovery cage collections containing *Hippelates pusio* and *bishoppi*, by locality

Locality	Months represented in collections[1]	Total cages[2]	No. of *pusio*	No. of *bishoppi*	Percent of *bishoppi*
Orlando, Florida	Jan., Febr., *Mar.*, Apr., Aug.-Dec.	51	376	5	1.3
Sanford, Florida	*Febr.-July*, Aug.-Dec.	131	4,430	128	2.8
Zellwood, Florida	Jan., Febr., *Mar.*-*Sept.*, Oct.-Dec.	107	3,556	1,419	28.5
Oviedo, Florida	Mar., Sept., Nov.	5	11	0	0.0
N. Fla., S. Ga.	*July*, *Aug.*	4	151	39	20.5

[1]Italics indicate months when *bishoppi* was recovered in addition to *pusio*.

[2]Based, in the miscellaneous settings, mainly on the numbering of the settings, which in only one instance are known to have included more than one cage.

tions leaves Bigham's conclusions regarding *pusio* unchanged and shows that *bishoppi* also breeds in cultivated or otherwise disturbed soil. Observations made in the region of Orlando, Florida, suggest that *bishoppi* bred more commonly in the spring, and was more abundant at Zellwood in a citrus-growing area than at Sanford where most of the land was in truck.

Each of 15 collections of gnats associated with various animals contained *pusio* but not *bishoppi*.

A NEW SPECIES OF ACNEUS

(COLEOPTERA, DASCILLIDAE)

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The genus *Acneus* was erected in 1880 by Dr. George H. Horn to receive his new species *quadrimaculatus*. The original description was based on a female from California. In 1881, Horn described the male from a specimen sent him by Ulke and presumed to have been collected in Oregon.

In describing and illustrating the male of the genus, Horn showed the third antennal segment to be longer than the first two combined, slender and slightly broader externally. Our males of the species fit all but this section of the description. In our series, the males have the third antennal segment longer than the first two combined but the segment is apically widened and flattened into an elongate triangular plate. An edge-on view of this segment resembles Horn's illustration, indicating that he used such a view in the description. For these reasons, I am assigning our specimens to the genus and all but one to his *A. quadrimaculatus*.

Our collection contains four representatives of Horn's species. One, a female, was collected at Boyer, Oregon, July 11, 1939. Three, two males and a female, were taken at Gunaldo Falls, Yamhill County, Oregon, June 30, 1949. These were taken flying above the creek a short distance below the falls. No additional notes are available on the Boyer specimen. A fifth specimen represents a new species which may be described as follows.

Acneus oregonensis, new species

Head piceous, the apical half of the labrum and the palpi testaceous, antennae piceous with the bases of segments 6 to 11 pale, pronotum flavous with the anterior marginal bead and a large median spot piceous, scutellum flavous, elytra flavous, each with seven blackish spots arranged as follows: three elongate spots laterally along the base; a rather obscure spot at about the middle; an elongate one interior to this and at the apical third; a marginal spot at the apical fourth and